REVISITING THE PSOCOPTERA (INSECTA) OF BARROW ISLAND, WESTERN AUSTRALIA

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Abstract

Courtenay Smithers recorded five species of Psocoptera on Barrow Island in 1982. Since then, repeated surveys have been conducted as part of environmental impact assessments associated with the Gorgon Project development on Barrow Island. This baseline information on invertebrates is to be utilised as a component of surveillance programs in support of the Gorgon Project's quarantine detection system. These additional surveys on the island have yielded a further 20 species of psocopterans, bringing the total fauna collected to 25 species. This includes the first Australian record of the synanthropic species *Dorypteryx domestica* (Smithers).

Introduction

Courtenay Smithers originally recorded five species of Psocoptera collected over 18 field days on Barrow Island during 1982 (Smithers 1984). Smithers described a new genus and two new species from this collection event, one of which was *Barrowia insularis* Smithers (Fig. 1). This psocid species has not been recorded so far from any other locality in Australia. The initial collection on Barrow Island was the start of the discovery of a surprising diversity of Psocoptera on this arid island, which lies off the northwestern coast of Australia and has become the site of Chevron Australia Pty Ltd's liquefied natural gas development, a part of the Gorgon Project (see acknowledgements). As a result of the environmental impact assessments associated with the development, extensive field surveys were conducted with the aim of providing baseline information on invertebrates. This baseline information is utilised as a component of a surveillance program in support of the Gorgon Project's Quarantine Management System. We present herewith a list of species collected to date on Barrow Island and provide an analysis of species distribution within the island. As data are lacking for the corresponding mainland psocid fauna, it is difficult to place this island fauna into a larger continental context. However, the existence of this body of work will hopefully enable other researchers to gain an understanding of the possible diversity of psocopterans in arid Australia.

This study forms part of a multi-million dollar biosecurity project which provides essential data for protecting Australia's biosecurity. More than 30 taxonomists were involved in identifying invertebrates from the baseline invertebrate survey of Barrow Island (Callan *et al.* 2011), including Courtenay Smithers. It is interesting to reflect that six of the taxonomists are retired scientists and four undertake taxonomic work only in their spare time. The diminishing number of salaried taxonomists in this country is disturbing, particularly considering the advanced age of many of those who assisted us, as evidenced by the sad passing away of our friend, Courtenay Smithers.

Fig. 1. Lateral view of a male specimen of *Barrowia insularis* Smithers from Barrow Island. This psocid species was collected by Courtenay Smithers and described in Smithers (1984).

Materials and methods

Barrow Island is located approximately 60 km from the North-West coast of Australia and is 234 km^2 in extent. The island receives, on average, 300 mm of rainfall annually. However, this is highly variable from year to year, with some years receiving less than 100 mm (*e.g.* 2009) and others receiving more than 700 mm (*e.g.* 1973) (BOM 2012). The majority of this rain falls in the hot, humid summer months of February and March, with a smaller amount falling in the cooler months of July and August. The most dominant vegetation complex on the island is *Triodia* hummock grasslands (Fig. 2). These are interspersed with *Acacia* stands and small clumps of *Ficus* trees. Mangroves (*Avicennia* and *Rhizophora*) occur in small patches along the coast (RPS Bowman Bishaw Gorham and Mattiske Consulting 2005).

Intensive surveys of invertebrates were carried out on Barrow Island between 2006 and 2007 and the results of these surveys have been reported in Callan *et al.* (2011), with species lists provided as an electronic appendix. This report recorded 19 species of Psocoptera in ten families. A variety of methods were used to capture invertebrates from the litter, ground surface, vegetation and other structures in a range of habitats distributed across the island (Figs 3-5). An extensive description of these methods and sites can also be found in Callan *et al.* (2011). All specimens from these surveys are lodged in the Australian Museum, with voucher reference specimens held in Curtin University Entomology Museum.

Figs 2-5. Environment and collecting techniques: (2) the east coast of Barrow Island is typified by low, spinifex covered dunes and sandy beaches with tidal flats – in the distance are five holding tanks for the oil that is pumped from below the island; (3) one of the collecting methods for invertebrates is night hand collection – many night-active flying insects are collected with this method; (4) another collection method commonly used for Psocoptera – beating or sweeping the vegetation into a collection tray or net often yields a number of invertebrate orders; (5) a leaf blower in suction mode is used to vacuum small invertebrates inhabiting vegetation – as spinifex is dense and spiky and unpleasant for hand collection, the blower vac is an effective method for collecting psocopterans within these tussocks.

Psocoptera were collected from 12 undisturbed native vegetation sites (classified as GP sites) in two seasons in 2006. The first collection was after the hot wet season in March and the second was carried out after the cooler dry season in September. Psocoptera were also collected from 13 disturbed habitat sites (classified as NIS sites) in 2006, which were visited again in 2007. The latter sites were chosen to see whether any non-indigenous species were present. A slightly modified collection protocol was carried out for the disturbed habitats to take into account the built environment present at these sites.

Table 1. The 25 Psocoptera species or morphospecies that have been collected from Barrow Island to date, in both native vegetation (N), disturbed habitats (D) and the built environment (B). Asterisked species were recorded by Smithers (1984) and species with a hash are cosmopolitan species found opportunistically since 2007. All species were identified by C. Smithers except *Dorypteryx domestica* and *Liposcelis bostrychophila*, which were identified by C. Taylor.

Family	Genus and Species	Habitat	Vegetation type
Amphientomidae	Amphientomid 1 sp. H	N, D	Spinifex on limestone ridge and floodplain
Caeciliusidae	*Caecilius* sp. T *	D	Rehabilitated site
Ectopsocidae	*Ectopsocus* nr. *erosus* (Enderlein)	D	Rehabilitated site
	Ectopsocus sp. B	N, D, B	Widespread on island
	Ectopsocus sp. N	N, D, B	Spinifex on limestone ridge and floodplain, coastal dunes
	Ectopsocus sp. P	N, B	Spinifex on limestone ridge
	Ectopsocus sp. R	D, B	Barge landing and rehabilitated sites
	Unknown Genus sp. Q	B	Camp and Warehouse
Lepidopscocidae	*Pteroxanium* sp. A	N, D, B	Widespread on island
Liposcelididae	Liposcelid 1 sp. D	N	Coastal dunes
	Liposcelid 2 sp. E	N	Coastal dunes
	Liposcelid 3 sp. J	N, B	Coastal dunes,spinifex on limestone ridgetop
	Liposcelid 4 sp. K	N, B	Spinifex on limestone ridgetop
	Liposcelid 5 sp. L	N	Spinifex on limestone floodplain
	Liposcelis bostrychophila Badonnel #	B	Camp
	Liposcelis entomophila (Enderlein) *	B	Camp
	Liposcelis sp. O (complex)	N, D, B	Widespread on island
Peripsocidae	*Peripsocus fici* Smithers *	B	Camp
Philotarsidae	Philotarsid 1 sp. G	N	Spinifex on limestone ridge
Pseudocaeciliidae	*Cladioneura foliata* Smithers *	N, D	Coastal dune, spinifex on limestone ridgetop
Psocidae	*Barrowia insularis* Smithers *	N, D, B	Widespread on island
Psyllipsocidae	*Dorypterx domestica* Smithers #	B	Camp
Trogiidae	*?Lepinotus* sp. F	N	Spinifex on limestone floodplain
	?Lepinotus sp. I	N, D	Coastal dunes
indet.	Gen. n. sp. M	N	Coastal dunes

Data were analysed as presence/absence. The collection protocol resulted in large volumes of invertebrates being collected, which meant that counting individuals was not time effective. For the GP sites, seasonal differences (wet/dry) in species richness were tested using an independent t-test. This was also done for species richness from two of the the collection periods (2006/2007) of the NIS sites. The statistical program PASW Statistics 18.0.2 was used to carry out this analysis. The GP and NIS site-by-species matrices were treated separately, as the collection protocols were not comparable. The species matrices from each season or survey were combined and a similarity matrix calculated for each site-by-species matrix using a Bray-Curtis similarity index (Bray and Curtis 1957). Each similarity matrix was then utilised to create a non-metric multidimensional scaling (NMDS) of the data to provide a visual presentation of how similar each site's species assemblage was in comparison with another site. These analyses were carried out using PRIMER-E v6.1.11.

Results

The 25 psocopteran species collected on Barrow Island from both native vegetation and disturbed habitat sites are listed in Table 1. The two most speciose families on the island are the Liposcelididae and Ectopsocidae. Included in the table are three synanthropic species that have been collected during surveys of the built environment on the island. These are *Liposcelis bostrychophila* Badonnel, *Liposcelis entomophila* (Enderlein) and *Dorypteryx domestica* (Smithers). *Liposcelis bostrychophila* and *D. domestica* have been collected in the built environment (Chevron pers. comm.) since the GP and NIS studies concluded. However, *L. entomophila* has not been collected since its first collection on the island in 1982 (Smithers 1984). Images of 21 of the psocopteran species of Barrow Island are publicly available and can be accessed at the website [www.padil.gov.au/barrow-island].

There appeared to be no significant difference between seasons for species richness at each GP site ($P > 0.1$). Species assemblage analysis did not yield any discernible trends in terms of similarity between sites, even when the assemblages from the two seasons were combined. Hence, the results from the NMDS are not displayed. For the NIS sites, no significant difference in species richness could be determined between the two surveys in 2006 and 2007 ($P > 0.1$). Here too, no discernible trends in species assemblages could be observed within the NIS sites.

Discussion

There are 252 described species of Psocoptera listed for Australia by Smithers (1996a), which is undoubtedly an underestimate due to the under-sampling of the northwestern part of the country (Schmidt and New 2008). For instance, Smithers (1996a) listed only four species of Liposcelididae for this area, fewer than present on Barrow Island alone (three further species of this family were recorded in the Western Australian wheatbelt by Smithers

1996b). Considering the remoteness of the northwestern part of Australia, the Barrow Island invertebrate fauna has been relatively well studied. Barrow Island has only slightly lower species diversity than other Australian offshore islands. Psocopteran collections on Lord Howe Island yielded 27 species (Smithers 2007) and 40 species were identified accumulatively on the four larger Bass Strait Islands (Cole *et al.* 1989).

The collection of an undescribed species of Amphientomidae is of interest as this is a rare family in Australia. Only three species have been described previously from Australia, all from single specimens (Smithers 1989, New 1994). In contrast, the Barrow Island amphientomid is known from several specimens, with both macropterous and brachypterous individuals present. A description is currently in preparation.

Psocoptera are generally associated with microflora (*e.g.* fungi, lichen, algae) and the highly seasonal arid environment on Barrow Island is not conducive to supporting a diverse psocopteran fauna. Despite collecting only five species, Smithers (1984) seemed to accept that such a low number of species was to be expected from such an arid island. The collection of an additional 18 species between 2006 and 2007 shows that a large number of species can be overlooked when only one method of collection is utilised. However, the island's highly seasonal environment and the generally accepted view that Psocoptera are easily dispersed by wind (New 1987) can also complicate species richness assessments.

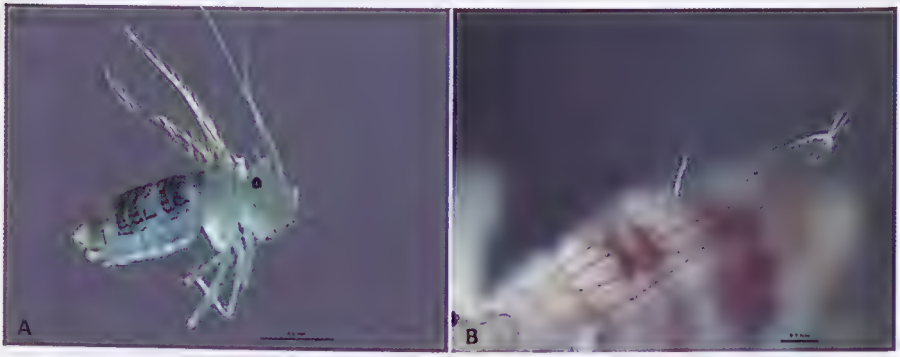

Fig. 6. *Dorypteryx domestica* female collected in accommodation block on Barrow Island: (a) lateral view; (b) close-up of forewing showing venation.

To date, only three widespread synanthropic species have been identified from the island. One of these, *Dorypteryx domestica* (Fig. 6), has not previously been recorded from Australia but is widely distributed, with records from Europe, North America and Africa (Mockford 1993). Their small size means that they easily escape detection in regions where they are

not previously known and their presence in Australia is not unexpected (T.R. New pers. comm.).

With few exceptions, *Dorypteryx* species are known almost entirely from synanthropic environments. Another species, *Dorypteryx longipennis* Smithers, was first described from Australia as a quarantine intercept (Smithers 1991), while *D. longipennis* and *D. pallida* Aaron are known to have cosmopolitan distributions similar to that of *D. domestica* (Lienhard and Schneider 1993, Mockford 1993).

Liposcelis bostrychophila and *L. entomophila* are also both widely distributed cosmopolitan species (Mockford 1993). Despite regular pest inspections of the built environment on Barrow Island and quarantine surveillance of the surrounding vegetation, these species are collected very rarely. *Liposcelis entomophila* is only known from its original collection in 1982. It is believed that these known cosmopolitan species are not permanent inhabitants of the built environment on Barrow Island and only occasionally re-occur within the man-made structures, possibly being blown over or being carried from the mainland. Their small size makes Psocoptera excellent wind dispersers, even wingless species, and *Liposcelis* specimens have been collected in wind traps on ships up to more than 1100 km from shore (Thornton and Harrell 1965). For a comparison with regards to synanthropic species, Lord Howe Island has four well known cosmopolitan species out of its 27 recorded species (Smithers 2007) and Norfolk Island has seven cosmopolitan species out of 21 (Smithers *et al.* 1999).

The fact that there did not appear to be any seasonal or annual collection differences in the species richness within the native vegetation and disturbed area sites perhaps points to a more stable fauna for the island. Also, the high ratio of un-named species to named species demonstrates the potential uniqueness of the fauna. Smithers was not able to put names on the majority of species from Barrow Island, which would indicate a high level of potential endemicity either for the island itself or the north-west of Australia in general.

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